

# Real Time Clocks 2020



# Standalone RTC Highlights

RTC Families:		
Lowest Power RTC Family	PCF8523, PCF2123	Ultra-low power, I <sup>2</sup> C or SPI Interface
Low Cost, Low Power RTC Family	PCF85063, PCF85063A, PCF85063B	Low power, I <sup>2</sup> C or SPI Interface
	PCF85263A	Low power, time-stamp & battery switchover
	PCF85363A	Low power, 64-Byte RAM
Accurate RTC Family	PCF2127(A)T/2, PCF2129(A)T/2	Highly accurate RTC, I <sup>2</sup> C and SPI Interface
Automotive RTC Family	PCA8565, PCA21125, PCA85073A	High temp. up to 125°C, I <sup>2</sup> C or SPI Interface
Accurate/Automotive RTC Family	PCA2129T/Q900/2	Highly accurate and AEC-Q100 compliant

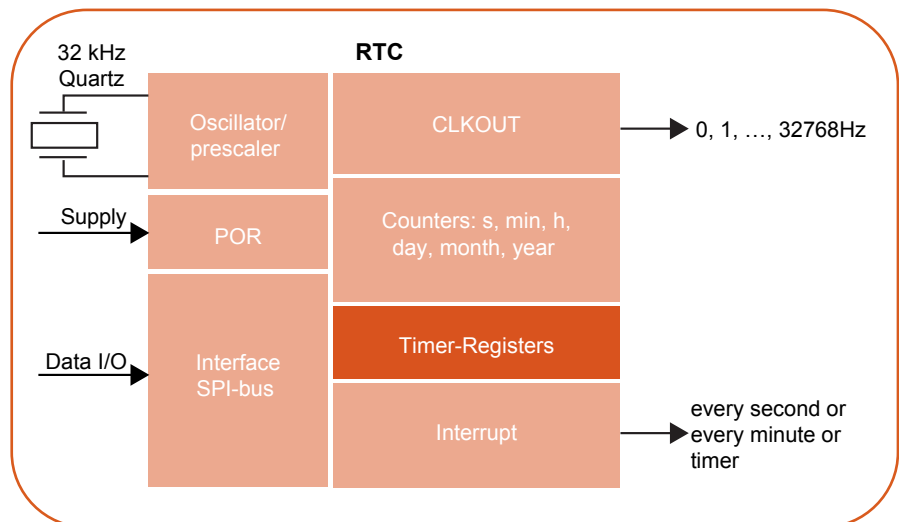
## KEY FEATURES

- › Time keeping
- › Low power; <100nA ICC (PCF2123)
- › Large voltage range; 1.5V to 5.5V
- › Clock from seconds to 99 years
- › Programmable Timer
- › Frequency output
- › Small packages (TSSOP8, HVSON10, etc)

## VALUE PROPOSITION

- › Time keeping
- › For highly accurate time-keeping, choose NXP RTCs with as low as  $\pm 3$ ppm accuracy
- › For long battery life, chose NXP RTCs with the industry's lowest current consumption of less than 100nA
- › For rugged environment applications, there is no way around NXP RTCs with extended temperature range up to 125°C and AEC-Q100 automotive compliant qualification

## RTC BLOCK DIAGRAM



# Key RTC Products

Type	Interface	Package	Status	Key features
<b>Industry Standard</b>				
PCF8563	I <sup>2</sup> C-Bus	SO8, TSSOP8, HVSON10	Production	Industry standard
<b>Tiny</b>				
PCF85063 PCF85063A	I <sup>2</sup> C-Bus	HWSO8 HXSON10, SO8, TSSOP8, Die	Production	Tiny footprint, best cost (PCF85063A with alarm)
PCF85063B	SPI Bus	HXSON10, Die	Production	Tiny footprint, best cost, alarm
<b>Latest Generation</b>				
PCF85263A	I <sup>2</sup> C-Bus	SO8, TSSOP8/10 HXSON10, WLCSP12	Production	Two alarms, watchdog, electronic tuning, battery management, time stamp (PCF85363A features also 64byte of RAM)
PCF85363A		TSSOP8/10, HXSON10		
<b>Lowest Power</b>				
PCF2123	SPI Bus	TSSOP14, HVQFN16, Die	Production	Lowest power (100nA), electronic tuning
PCF8523	I <sup>2</sup> C-Bus	SO8, TSSOP14 HVSON8, Die	Production	Low power (100nA), electronic tuning Battery management
<b>Precise</b>				
PCF2129A PCF2127A	I <sup>2</sup> C-Bus/ SPI Bus	SO20	Production	High accuracy ±3ppm, -25°...+65°C Battery management, Time stamp, metal can quartz (PCF2127A features also 512byte RAM)
PCF2129 PCF2127	I <sup>2</sup> C-Bus/ SPI Bus	SO16	Production	High accuracy ±3ppm, -40°..+85°C Battery management, Time stamp, ceramic quartz (PCF2127 features also 512byte RAM)
<b>Automotive</b>				
PCA8565	I <sup>2</sup> C-Bus	TSSOP8, Die	Production	Robustness: up to 125°C
PCA21125	SPI Bus	TSSOP14	Production	Robustness: up to 125°C
PCA2129	I <sup>2</sup> C-Bus/ SPI Bus	SO16	Production	High accuracy ±3ppm, Battery management, Time stamp, ceramic quartz for automotive: up to 85°C
PCA85073A	I <sup>2</sup> C-Bus	TSSOP8	Production	Replacement for PCA85063A, Tiny footprint, alarm, up to 105°C

# RTC Selector Guide

RTC Portfolio	PCF8563	PCF85063A/B	PCF85263	PCF85363	PCF8523	PCF2123	PCF2127	PCF2129	PCA21125
Time	√	√	√	√	√	√	√	√	√
Alarm	√	√	√ 2x	√ 2x	√	√	√	√	√
Timer/ Watchdog	√	√	√	√	√	√	√	√	√
Interrupt	√	√	√ 2x	√ 2x	√ 2x	√	√	√	√
Stop watch			√	√					
Time stamp			√ 3x	√ 3x			√	√	
Time stamp/ Tamper input			√	√			√	√	
Battery Bbackup			√	√	√		√	√	
Tuning register		√	√	√	√	√	√	√	
Temperature Compensation							√	√	
Factory calibration							√	√	
Quartz crystal							√	√	
RAM integration				√			√		
High temperature	PCA8565	PCA85073A							√
AEC-Q100 Automotive	PCA8565	PCA85073A						PCA2129	√
Interface	I <sup>2</sup> C-Bus	I <sup>2</sup> C-Bus, SPI	I <sup>2</sup> C-Bus, SPI	I <sup>2</sup> C-Bus, SPI	I <sup>2</sup> C-Bus	SPI	I <sup>2</sup> C-Bus, SPI	I <sup>2</sup> C-Bus, SPI	SPI

# PCF85063: Small Footprint, Low-Power RTC

Function	PCF85063TP	PCF85063A	PCF85063B
Electronic tuning	Yes	Yes	Yes
I <sup>2</sup> C-bus SPI interface	√	√	√
1 min interrupt	No	Yes	Yes
Alarm facility	No	Yes	Yes
Timer	No	Yes	Yes
CLK out	Yes	Yes	Yes
CLK enable	No	Yes	Yes
Interrupt output	Yes	Yes	Yes
Package SOT number	HWSO8-8 <sup>[1]</sup>	SO8, TSSOP8, HXSON-10, Die	HXSON-10, Die

<sup>[1]</sup> 0.5-mm pitch

## AVAILABLE VERSIONS:

- › **PCF85063TP:** I<sup>2</sup>C-bus, Limited feature set, 8-pin package
- › **PCF85063A:** I<sup>2</sup>C-bus, Full feature set, 8 & 10-pin package
- › **PCF85063B:** SPI-bus, Full feature set + CLKOUT, 10-pin package
- › **PCA85073A:** I<sup>2</sup>C-bus, Full feature set, Automotive Qualified

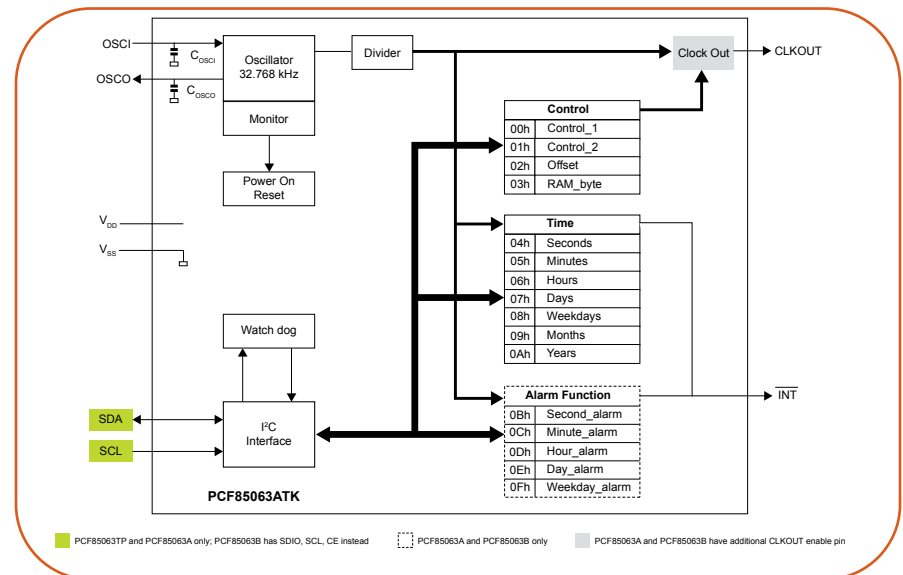
## KEY FEATURES

- › Cost optimized
- › Low-power consumption; At  $V_{DD}=2.0V$ ,  $T_{AMB}=25\text{ }^{\circ}C$ , no bus activity and CLKOUT active,  $I_{DD}=260\text{ nA (typ)}$
- › Very small footprint packages
  - HWSO8 (2 x 3 x 0.8mm)
  - HXSON10 ( 2.6 x 2.6 x 0.5mm)
  - SO8
  - TSSOP8
- › Two interfaces supported; I<sup>2</sup>C and SPI
- › Two integrated programmable oscillator capacitors
  - For 7-pF load
  - For 12.5-pF load
- › Electronic Tuning

## TARGET APPLICATIONS

- › Printers
- › Copy Machines
- › Digital Still Cameras
- › Digital Video Cameras

## PCF85063: SMALL FOOTPRINT, LOW-POWER RTC BLOCK DIAGRAM



# PCA85073A: Automotive, Small Footprint, Low-Power RTC

## KEY FEATURES

- ▶ Low-power consumption; At  $V_{DD}=3.0V$ ,  $T_{AMB}=25\text{ }^{\circ}\text{C}$ , no bus activity and CLKOUT inactive,  $I_{DD}=250\text{ nA}$  (typ)
- ▶ Operating temperature range from  $-40\text{ }^{\circ}\text{C}$  to  $105\text{ }^{\circ}\text{C}$
- ▶ Small package footprint
  - TSSOP8,  $5.1 \times 3.1 \times 1.1\text{mm}$ ;
  - $0.65\text{-mm}$  pitch
- ▶ I<sup>2</sup>C-bus interface supported
- ▶ Two integrated programmable oscillator capacitors
  - For  $7\text{-pF}$  load
  - For  $12.5\text{-pF}$  load
- ▶ Offset Register for fine tuning the clock for accuracy, aging adjustment or temperature compensation
- ▶ Interrupt output supports counter timer, alarm, minute and half-minute interrupt
- ▶ Push-pull CLKOUT output

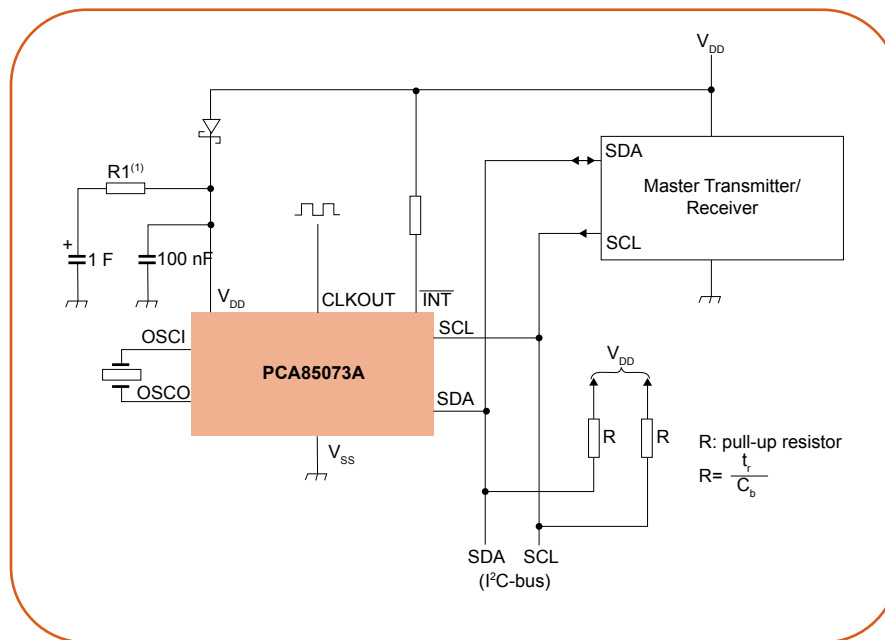
## TARGET APPLICATIONS

- ▶ Electric Car Battery Management
- ▶ Charging Stations
- ▶ Body Control Module

## AVAILABLE VERSION:

- ▶ PCA85073ADP/Q900: I<sup>2</sup>C-bus, Full feature set, TSSOP-8 package
- ▶ Improved package drop in replacement for PCA85063ATT

## PCA85073A BLOCK DIAGRAM



# Comparison: PCF8563, PCF85063, PCF85063A, & PCF85063B

Parameter / Feature	PCF8563	PCF85063	PCF85063A	PCF85063B
Interface	I <sup>2</sup> C-bus, 400kHz	I <sup>2</sup> C-bus, 400kHz	I <sup>2</sup> C-bus, 400kHz	SPI bus, 8MHz
Operating Supply Voltage	1.0V to 5.5V	0.9V to 5.5V	0.9V to 5.5V	0.9V to 5.5V
Interface Active Supply Voltage	1.8V to 5.5V	1.8V to 5.5V	1.8V to 5.5V	1.6V to 5.5V
CLKOUT Output	Open-drain	Push-pull	Push-pull (With CLKOE)	Push-pull (with CLKOE)
Programmable CLKOUT Frequency	32.768 kHz, 1.024 kHz, 32Hz, 1Hz, Off (CLKOUT=High-Z)	32.768 kHz, 16.3484kHz, 8.192kHz, 4.096kHz, 2.048kHz, 1.024 kHz, 1Hz, Off (CLKOUT=Low)	32.768 kHz, 16.3484kHz, 8.192kHz, 4.096kHz, 2.048kHz, 1.024 kHz, 1Hz, Off (CLKOUT=Low)	32.768 kHz, 16.3484kHz, 8.192kHz, 4.096kHz, 2.048kHz, 1.024 kHz, 1Hz, Off (CLKOUT=High-Z)
Alarm / Timer	Yes	No	Yes	Yes
Selectable Quartz CL Tuning Capacitance	12.5pF (typical); 1 internal and 1 external	7pF or 12.5pF (Both Internal)	7pF or 12.5pF (Both Internal)	7pF or 12.5pF (Both Internal)
Automatic Interrupt (30 sec or 1 min)	No	Yes; Can also be disabled	Yes; Can also be disabled	Yes; Can also be disabled
Electronic Tuning	No	Programmable offset register for frequency adjustment	Programmable offset register for frequency adjustment	Programmable offset register for frequency adjustment
RAM	No	1 Byte	1 Byte	1 Byte
Packages	TSSOP8, SO8, HVSON10	HVSON8	HXSON10, SO8, TSSOP8, Die	HXSON10, Die

# Introducing PCF85263 & PCF85363

## Full Featured Real Time Clocks

Type / Function	PCF8563	PCF85063	PCF85063A PCF85063B	PCF85263A	PCF85363A
RTC, resolution Elapsed time counter	1s... years no	1s... years no	1s... years no	1/100s... years yes	1/100s... years yes
Alarm facility Timer, Watchdog	1 Alarm Timer, counter	None	1 Alarm 1 Timer	2 Alarms and Watch dog	2 Alarms and Watch dog
Time Stamp	No	No	No	Yes 2	Yes 2
Battery backup input	No	No	No	Yes	Yes
RAM	No	1 Byte	1 Byte	1 Byte	64 Byte
Interrupts Interrupt pins	Universal 1	30 s, 1 min 1	30 s, 1 min, universal 1	universal 2, 1 in SO8	universal 2, 1 in SO8
Interface	I <sup>2</sup> C-bus 400 kHz	I <sup>2</sup> C-bus 400 kHz	A = I <sup>2</sup> C-bus 400 kHz B = SPI 6.5 MHz	I <sup>2</sup> C-bus 400 kHz	I <sup>2</sup> C-bus 400 kHz
RTC electronic tuning Quartz, load capacity CL =	No with external C	Yes 7pF / 12.5pF	Yes 7pF / 12.5pF	Yes 6pF/ 7pF / 12.5pF	Yes 6pF/ 7pF / 12.5pF
Package	SO8, TSSOP8, HVSON10	HWSON 8 2 x 3 x 0.8mm Tiny package	HXSON 10 2.6 x 2.6 x 0.5mm, Die with SO8, TSSOP8 for PCF85063A only	HXSON 10 2.6 x 2.6 x 0.5mm, SO8, TSSOP8/10, WLCSP12	HXSON 10 2.6 x 2.6 x 0.5mm, TSSOP8/10

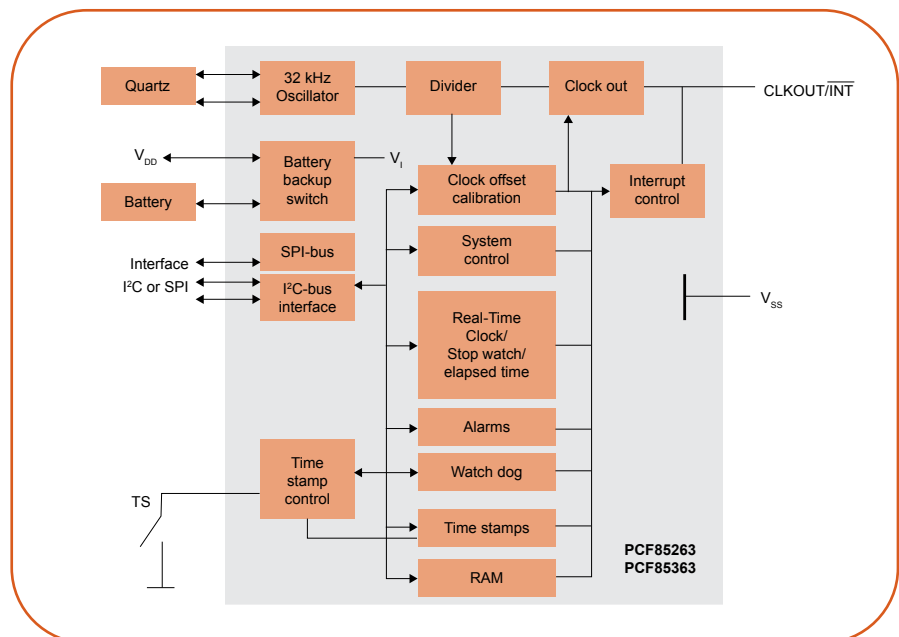
### KEY FEATURES

- Low-power consumption; At  $V_{DD}=3.0V$ ,  $T_{AMB}=25\text{ }^{\circ}C$ , No bus activity and CLKOUT inactive,  $I_{DD}<300nA$  (typ)
- Additional integrated features
  - 1/100 s resolution RTC, stop-watch or elapsed time counter
  - Battery backup input
  - Time Stamps for tamper detection and battery switchover
  - Watchdog
  - Elapsed time counter
  - Battery backed-up RAM

### TARGET APPLICATIONS

- Consumer
- Industrial
- Computing/Networking
- Medical Equipment
- Power Supplies

### PCF85263A/363A BLOCK DIAGRAM



### PART NUMBERS:

- PCF85263A: I<sup>2</sup>C-bus (1-Byte RAM)
- PCF85363A: I<sup>2</sup>C-bus (64-Byte RAM)

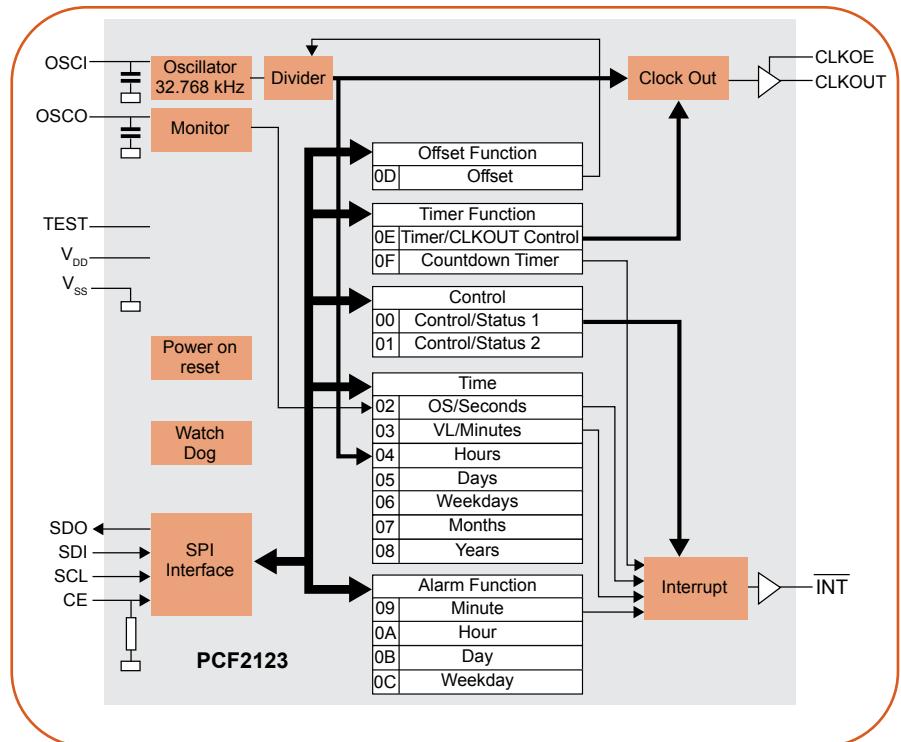


# PCF2123: Ultra-low Power RTC with SPI Interface

## KEY FEATURES

- ▶ Ultra low power 100nA @ 2V (typ.)
- ▶ Large voltage range 1.5...5.5V
- ▶ SPI bus up to 6 MHz
- ▶ Clock from seconds to 99 years
- ▶ Programmable Countdown Timer
- ▶ Programmable Output Clock Frequency with Output Enable pin
- ▶ Electronic tuning
- ▶ Small packages TSSOP14, HVQFN16 and U (die)
- ▶ Supply current as low as 100nA (typ.) at  $V_{DD} = 2.0V$  and  $T_{AMB} = 25\text{ }^{\circ}C$

## PCF2123 BLOCK DIAGRAM

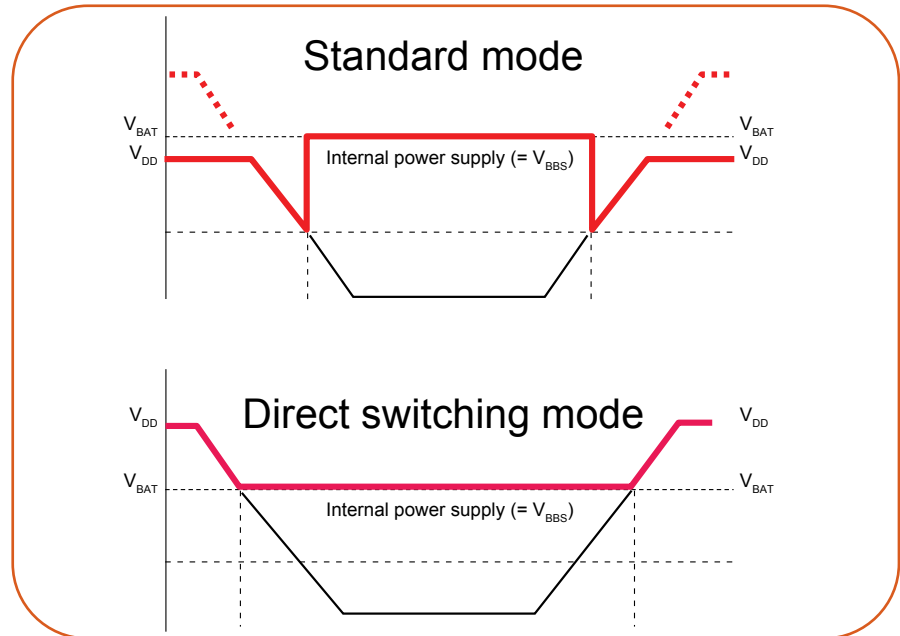


# PCF8523: Low Power RTC with I<sup>2</sup>C Interface

## KEY FEATURES

- ▶ Ultra low power 150nA @ 3V (typ.)
- ▶ Large voltage range 1.6...5.5V
- ▶ 1 MHz Fast-mode Plus (Fm+) I<sup>2</sup>C Interface
- ▶ Clock from seconds to 99 years
- ▶ Programmable Countdown Timer
- ▶ Programmable output clock
- ▶ Power Fail Detection Function
- ▶ Battery Switch-Over Function
- ▶ Battery Low Detection Function
- ▶ Electronic Tuning
- ▶ Packages: SO8, TSSOP14, HVSON8 and U (die)
- ▶ Supply current as low as 150nA (typ.) at  $V_{DD} = 3.0V$  and  $T_{AMB} = 25\text{ }^{\circ}C$

## PCF8523 BATTERY BACK UP

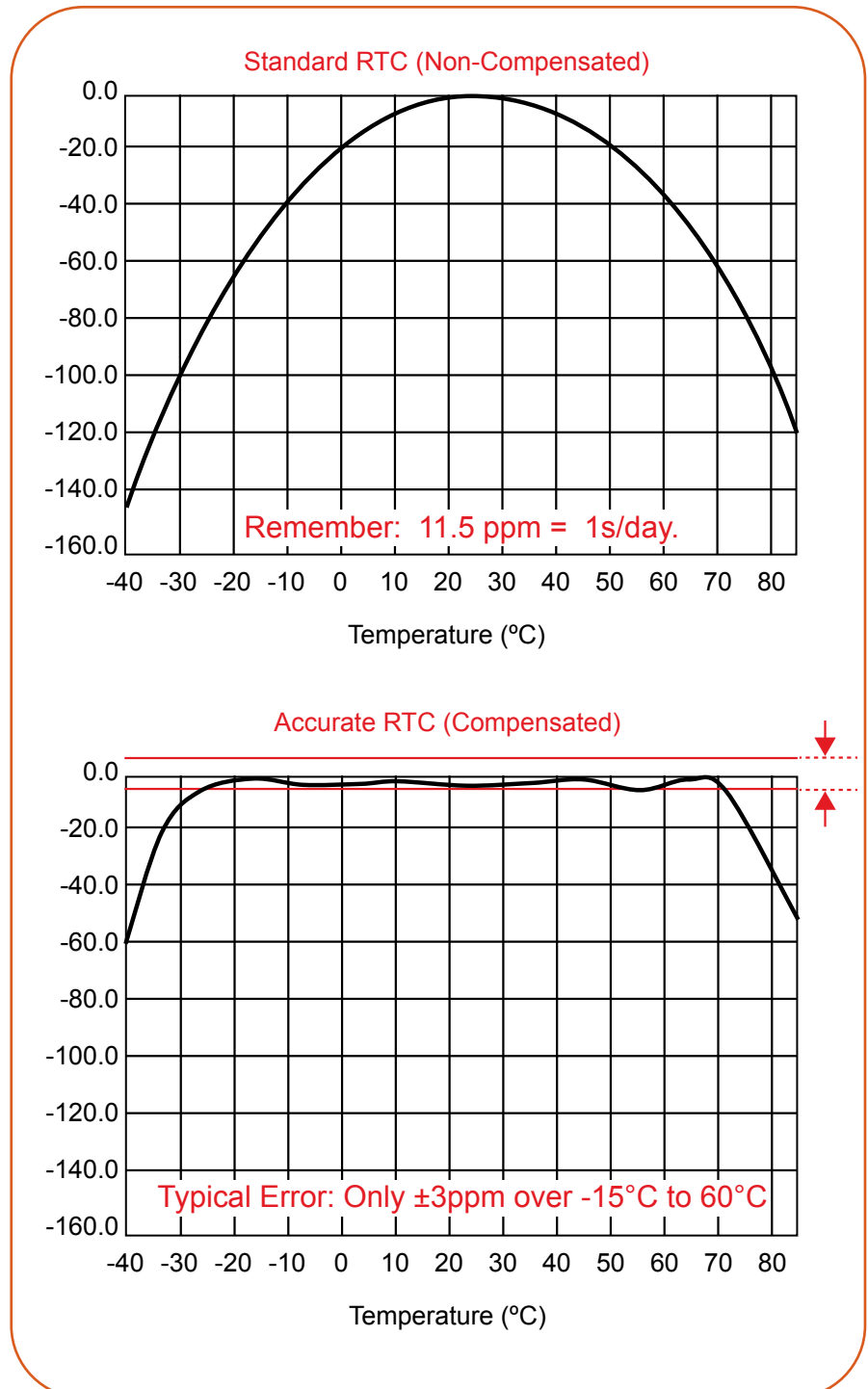


# PCF2127A / 29A: Low-Power Accurate Real Time Clock (aRTC)

## KEY FEATURES AND BENEFITS

- ▶ High accuracy ( $\pm 3\text{ppm}$ ; typ.) for accurate time reference
- ▶ Ultra-low power consumption enables long battery life
  - $\sim 500\text{nA}$  @  $V_{\text{DD}}=2.0\text{V}$  and  $T_{\text{AMB}}=25^\circ\text{C}$
- ▶ Integrated quartz crystal requires no external quartz
- ▶ Integrated TCXO with temperature compensation circuit requires no external temperature sensor and no temperature dependent tuning
- ▶ Battery backup and switchover functionality ensures reference timekeeping during power down
- ▶ Factory calibrated and ready at very first power up
- ▶ No external capacitors required and no re-calibration required to compensate for aging
- ▶ Integrated 512-byte RAM (PCF2127A) for retaining critical data during power down
- ▶ SPI and I<sup>2</sup>C Interface (selectable)
- ▶ SO20 Package

## CURACY OVER TEMPERATURE



# PCF2127A / 29A: Low-Power Accurate Real Time Clock (aRTC)

## PCF2127A & PCF2129A FEATURE LIST

Type	PCF2127A	PCF2129A
Operating Temp. Range	-40°C, ..., +85°C	-40°C, ..., +85°C
Accuracy (typ)	±3 ppm; from -15°C to 60°C ±5 ppm; from -25°C to -15°C ±5 ppm; from +60°C to +65°C	±3 ppm; from -15°C to 60°C ±5 ppm; from -25°C to -15°C ±5 ppm; from +60°C to +65°C
Interface	I <sup>2</sup> C and SPI	I <sup>2</sup> C and SPI
RAM	512 Byte	–
Package	SO20	SO20
Supply Voltage Range VDD	1.8V – 4.2V	1.8V – 4.2V
Battery Supply Voltage Range VBat	1.8V – 4.2V	1.8V – 4.2V
Supply Current (typ.)	500nA @ 2.0V and Tamb=25°C	500nA @ 2.0V and Tamb=25°C
Battery Switch over function	Yes	Yes
Battery Low-Detection Function	Yes	Yes
Extra Power Fail Detection Function	Yes	No
Battery backed Output Voltage Pin	Yes	Yes
Reset Output Pin	Yes	No
Countdown timer and watch dog function	Yes	Watchdog only
Time Stamp Function	Yes	Yes

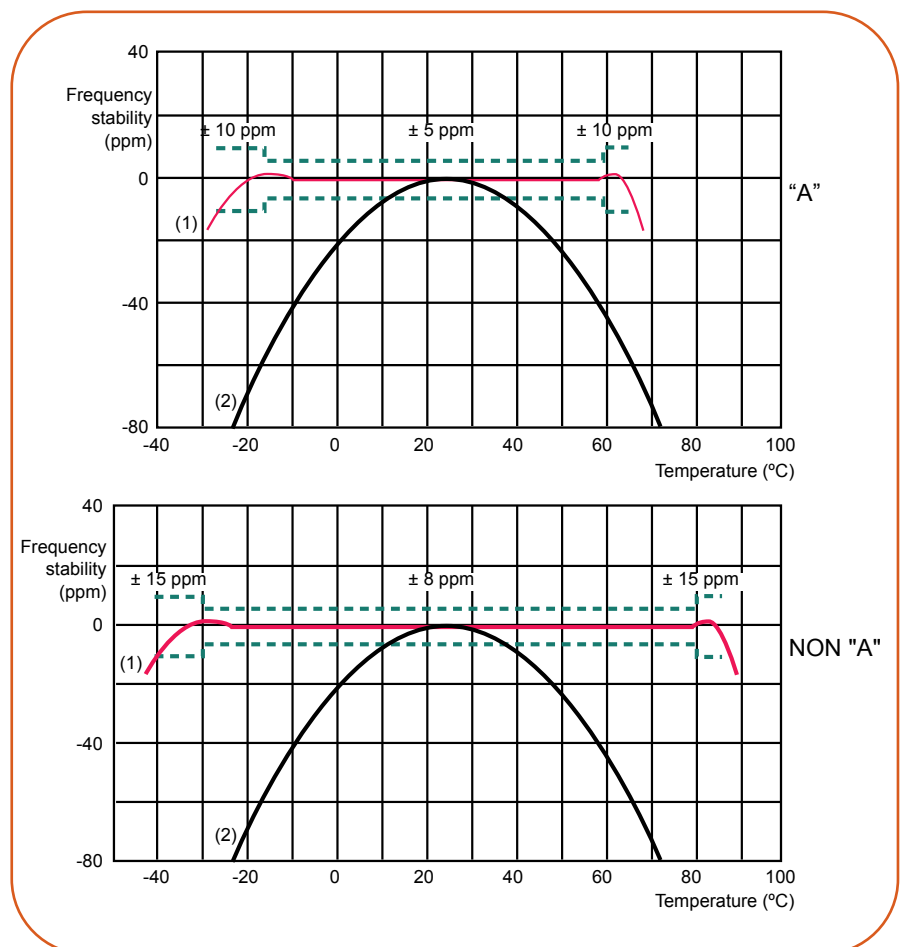
# PCF212XA vs PCF212x: Differences in Accuracy

Type number	PCF2127AT/2, 2129AT/2	PCF2127T/2, 2129T/2
Version	Industrial	Industrial
Grade	General Quality spec GQS	General Quality spec GQS
Frequency accuracy	+/- 5ppm -15°C...+60°C +/-10ppm -25...15, 60..65°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C
Construction	Metal can quartz	Ceramic quartz
Silicon foundry	TSMC Taiwan	TSMC Taiwan
Assembly fab	APB Bangkok Thailand	APB Bangkok Thailand
Wafer and final test	APB Bangkok Thailand	APB Bangkok Thailand
Package	SO20	SO16 drop in to SO20 PCB footprint since SO20 has four NC pins
Quartz Type	Metal Can Package	Ceramic Package

## KEY FEATURES

- ▶ The PCF212XC comprises a Real Time Clock (RTC) and a temperature compensated quartz oscillator (TCXO). The quartz crystal itself is integrated into the package.
- ▶ There are 2 major version one in SO20, the other one in SO16 package. They feature different accuracy due to use of different type of crystal.
- ▶ "A" has higher accuracy
- ▶ Non "A" has wider temperature range.

## "A" VS NON "A" ACCURACY OVER TEMPERATURE



# PCA2129: Automotive Qualified Accurate Real Time Clock (aRTC)

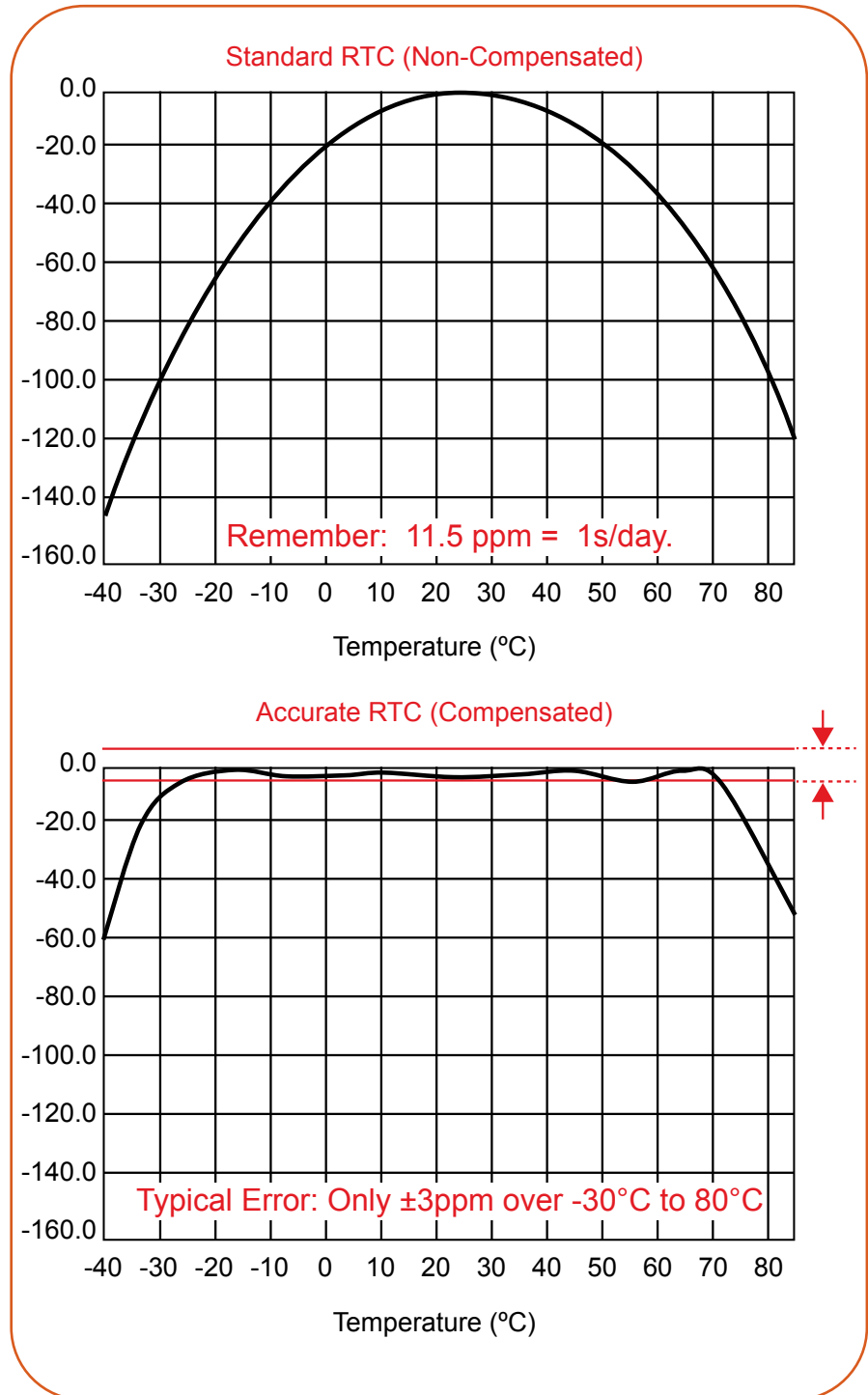
## KEY FEATURES AND BENEFITS

- High accuracy ( $\pm 3\text{ppm}$ ; typ.) for accurate time reference
  - $\pm 3\text{ppm}$  accuracy  $-30^\circ\text{C}$  to  $+80^\circ\text{C}$
  - $\pm 5\text{ppm}$   $-40^\circ\text{C}$  to  $-30^\circ\text{C}$
  - $\pm 5\text{ppm}$   $+80^\circ\text{C}$  to  $+85^\circ\text{C}$
- Temperature Range from  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$
- Voltage Supply from 1.8V to 4.2V
- Ultra-low power consumption enables long battery life
  - $\sim 500\text{nA}$  @  $V_{\text{DD}}=2.0\text{V}$  and  $T_{\text{AMB}}=25^\circ\text{C}$
- Integrated quartz crystal requires no external quartz
- Integrated TCXO with temperature compensation circuit requires no external temperature sensor and no temperature dependent tuning
- Factory calibrated and ready at very first power up
- SPI and I<sup>2</sup>C Interface (selectable)
- SO16 Package
- AEC Q100 Compliant

## TARGET APPLICATIONS:

- Electric Car Battery Management
- Charging Stations
- Body Control Module

## TEMPERATURE RESPONSE COMPARISON



# Comparison: NXP Accurate Real Time Clocks

Type number	PCF2127AT/2	PCF2129AT/2	PCF2127T/2	PCF2129T/2	PCA2129T/Q900/2
Version	Industrial	Industrial	Industrial	Industrial	Automotive
Grade	General Quality spec GQS	General Quality spec GQS	General Quality spec GQS	General Quality spec GQS	AEC-Q100 Grade 3
Package	SO20	SO20	SO16 drop-in compliant to SO20	SO16 drop-in compliant to SO20	SO16
Frequency accuracy	+/- 5ppm -15°C...+60°C +/-10ppm -25...-15, 60..65°C	+/- 5ppm -15°C...+60°C +/-10ppm -25...-15, 60..65°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C
Construction	Metal can quartz	Metal can quartz	Ceramic quartz	Ceramic quartz	Ceramic quartz
Silicon foundry	TSMC Taiwan	TSMC Taiwan	TSMC Taiwan	TSMC Taiwan	TSMC Taiwan
Assembly fab	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand
Wafer and final test	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand	APB Bangkok Thailand
	2129 plus 512 Byte RAM count down timer reset output pin		2129 plus 512 Byte RAM count down timer reset output pin		

## KEY FEATURES

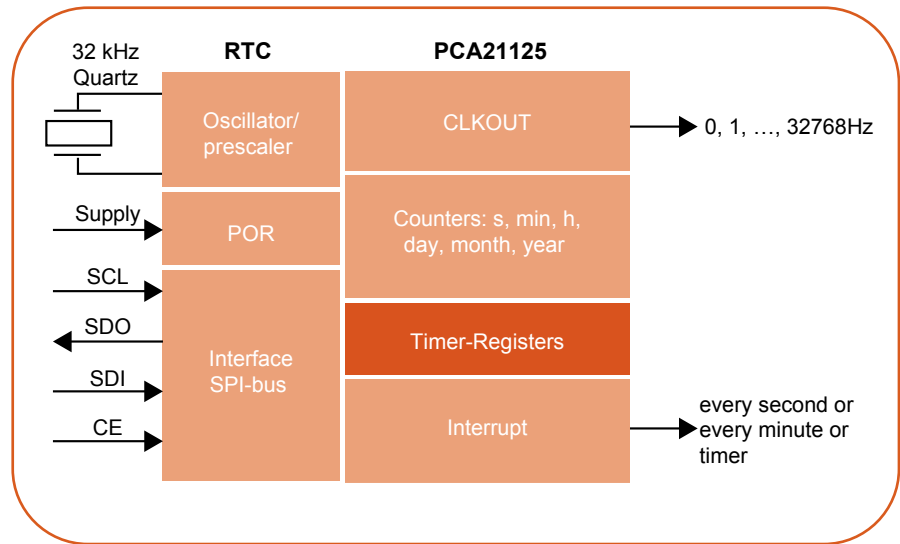
- › The aRTC comprises a Real Time Clock (RTC) and a temperature compensated quartz oscillator (TCXO).
- › The quartz crystal is integrated in the package.
- › No need for further tuning over time; Just set the clock time once.
- › The type names are quite similar, but simply the 27 has more features and RAM then the 29 and the "A" have more accuracy but less temperature range then the non "A".

# PCA21125: RTC with SPI bus ( $T_{\text{ambient}} = -40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ )

## KEY FEATURES AND BENEFITS

- › Extended Temp. Range:  $-40$  to  $+125^{\circ}\text{C}$
- › Low power  $< 860\text{nA}$
- › Large voltage range 1.5, ..., 5.5V
- › SPI bus up to 6MHz
- › Clock from seconds to 99 years
- › Programmable Timer
- › Frequency output
- › Small package TSSOP14
- › AEC Q100 compliant
- › High-temperature Variant ( $+125^{\circ}\text{C}$ )
- › Allows for automotive or other high-temp applications thanks to extended temperature range

## PCA21125 BLOCK DIAGRAM





# Real Time Clock Design Support

RTC	Eval Board	User Manual
PCF2123	OM13512 †	UM10759
PCF8523	OM13511 †	UM10670
PCF2127, 29	OM13513 †	UM10762
PCF85063B	OM11059 †	UM10699
PCF85063A	OM11059A	UM10698
PCF85263A	OM13510 †	UM10766
PCF85363A	OM13514 †	UM10787

† Available on eDemoboard



# Real Time Clock Application Notes

**AN10652:**

Improved Timekeeping Accuracy with PCF8563 Using External Temperature Sensor

**AN10857:**

Application and Soldering Information for PCF2127A and PCF2129A TCXO RTCs

**AN11120:**

Application and Soldering Information for PCA2129 Automotive TCXO RTC

**UM10301:**

User Manual for NXP Real Time Clocks PCF85x3, PCA8565 and PCF2123, PCA2125

**UM10698:**

User Manual for I2C-Bus RTC Demoboard OM11059A

**UM10699:**

User manual for SPI-bus RTC Demoboard OM11059

# Technical Contact

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